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HEAT IT UP!

Background Information

A solar pond is a body of water that collects radiant energy and stores thermal energy.

In an ordinary pond, thermal energy is lost at the surface as denser cold water moves towards the bottom and warm water expands and rises to the top. Solar ponds minimize heat loss due to convective circulation or evaporation. Convective circulation is the transmission of energy by movement of air, gas, or liquid currents.

There are two types of nonconvective solar ponds: salt-gradient ponds and membrane ponds. Salt-gradient ponds are large, shallow human-made bodies of water lined with dark material. The pond has three main water layers: the surface zone, the gradient zone, and the storage zone. The gradient zone separates the surface zone and the storage zone. The salt content in the gradient zone increases with depth. Warm water in the gradient zone can't rise because the water above it contains less salt and therefore is less dense. Similarly, the cool water can't sink because the water below it has a higher salt content and is denser. Hot water in the storage zone is piped to a boiler where it is heated further to produce steam, which drives a turbine.

A membrane solar pond blocks convection by physically blocking the mixing of the layers, by separating the layers of water with thin transparent membranes. As with salt-gradient ponds, hot water is removed from the bottom layer.

In this investigation the inversion of temperature in a salt pond will be demonstrated and compared to an ordinary pond.

Problem *(fill in problem):* _____

_____

Hypothesis If _____

then _____

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INVESTIGATION CONT.

Materials

1 hot plate
2 600 ml beakers
2 thermometers
1 one-gallon plastic bag
salt
measuring cup

Procedure

1. Put 500 ml of tap water into one of the beakers.
2. Take the initial temperature of the water at the top and bottom of the beaker. Record the temperatures on the data table.
3. Using the measuring cup, measure 250 ml of tap water.
4. Pour 1/4 cup of salt into the 250 ml of water and stir until dissolved.
5. Continue adding salt a little at a time until the water will not dissolve any more salt and the salt begins to separate (precipitate) out of the salt-water solution.
6. Pour 250 ml of the salt-water solution into the second beaker.
7. Cut the plastic bag open.
8. Place the plastic over the salt-water solution.
9. Using the measuring cup, measure another 250 ml of tap water.
10. Slowly pour this water on top of the plastic.
11. Carefully pull the plastic wrap out from between the two layers of water.
12. Take the initial temperature of the water at the top and bottom of the beaker and record on the data table.
13. Place both beakers on top of the hot plate and heat for 10-15 minutes (do not allow water to boil).
15. Being careful not to disturb the salt-water gradient, take the temperature of the water at the top and bottom of each beaker and record.

Observations

Type of water	Beginning temp. C° bottom / top	Ending temp. C° bottom / top
Salt water	/	/
Fresh water	/	/

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INVESTIGATION CONT.

Conclusion

1. Explain why the salt water had a temperature gradient. _____

   _____

2. Explain why the fresh water did not have a temperature gradient. _____

   _____

3. As a model for solar ponds, what major flaw can you see in this model and how could it be corrected? _____

   _____

Application

1. What environmental problems could occur if a salt-water pond were to leak?

   _____

   _____

2. Describe the best type of environment for a solar pond. _____

   _____

3. One application for solar ponds is the desalination of water, the removal of salt from salt water by evaporation and condensation. This application is currently being used in the deserts of Australia, which has a significant source of salt water underground. Give three reasons why this has the potential to be profitable.

   _____

   _____

   _____

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4. Oceans cover a little more than 70 percent of the earth's surface. This makes them the world's largest solar collector and energy storage system. Ocean Thermal Energy Conversion (OTEC) is an energy technology that converts solar radiation to electric power by using the sun-warmed water to generate electricity. The sun-warmed water is "flash" evaporated to produce steam to spin a turbine. How could this process be used to provide fresh water to local communities?

_____

_____

5. Ocean water contains 57 elements. How might OTEC serve as a means of mining the ocean in the future?

_____

_____

Going further

1. Research and explain how solar ponds could be used in aquaculture applications.

_____

_____

_____